Elveflow® MUX Flow Switch Matrices

USER GUIDE

October 2014

ELVEFLOW
PLUG & PLAY MICROFLUIDICS

READ THIS MANUAL CAREFULLY BEFORE USING THE INSTRUMENT

This manual must be read by any person who is or will be responsible for using, maintaining or repairing the MUX Flow Switch.

Due to the continual development of the products, the content of this manual may not correspond to the new product. Therefore, we retain the right to make alterations without prior notification.

Important MUX safety notices:

1. The MUX must be used in a **clean and dry environment**, with up to 60% relative humidity.
2. Use a power cord of the correct voltage. The MUX requires a **24 V DC input voltage**.
3. The pressure at applied to the valves must **not exceed 2 bar**.
4. Fluids used with the instrument must be **chemically compatible**with PEEK, FKM (Viton), POM (Delrin) and stainless steel (316). The latter is not applicable to the MUX Standard 2/2.
5. **No solids**should enter the MUX.
6. If possible, **filter the media**.
7. The MUX Premium must be used exclusively with**neutral, dry, dust- and oil-free, and particle-filtered gases**, at a minimum of5 µm particle size. Please refer to ISO 8573-1, cl. 3 for detailed information.
8. **Clean the MUX** before storing it.
9. **Do not allow any liquid to dry inside the valves of theinstrument.**
10. **Do not store the instrument with liquid inside it.**

IF THESE CONDITIONS ARE NOT MET, THE USER IS EXPOSED TO DANGEROUS SITUATIONS AND THE INSTRUMENT CAN UNDERGO PERMANENT DAMAGE. ELVESYS AND ITS PARTNERS CANNOT BE HELD RESPONSIBLE FOR ANY DAMAGE RELATED TO THE INCORRECT USE OF THE INSTRUMENTS.

Contents

I. Description

The Elveflow® MUX flow switch matrices are designed for fast fluid injection into microchannels but also instantaneous flow stop and low volume sample injection into microchannels.

The MUX flow switch is the first professional solution which enables intuitive programming of complex fluidic sequences in a microfluidic device. When used with Elveflow® pressure controllers and liquid tanks, the MUX flow switch matrices enables to instantaneously stop the flow in either microfluidic devices or capillaries.

The Elveflow® MUX instrument is controlled by a computer through USB connection, using the Elveflow® Smart Interface that allows you to configure and perform programmable flow switch sequences in your device.

Last but not least, the Elveflow® Smart Interface allows recording and exporting the data generated by all the Elveflow® instruments connected and involved in your experiment.

Prior to use

Before setting up your OB1, please check the package contents to verify that you have received the items below:

1. The instrument;
2. a USB flash drive containing the Elveflow® Smart Interface software and the user guides;
3. a USB cable;
4. a power supply unit;
5. specific gas and liquid tight fittings.

Optional Accessories:

You may have ordered some additional elements (e.g. flow sensor units, reservoirs, tubing) so please check that you have received all the corresponding items.

If any parts are missing or damaged, please get in touch with Elveflow support immediately:

contact@elveflow.com

II. Setup and use

Getting started

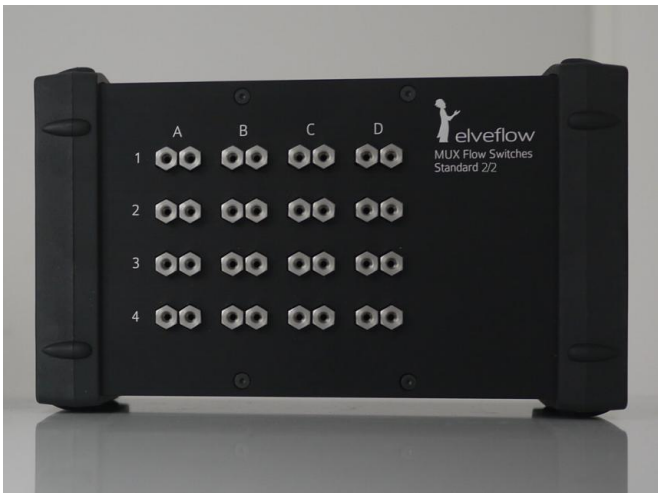
Three models of MUX Flow Switch Matrices are available: MUX Standard 2/2, MUX Standard 3/2, and MUX Premium. These instruments use electromechanically operated solenoid valves that can be actuated through the Elveflow® Smart Interface. With these instruments you will be able to perform various tasks such as fast sample injection, medium perfusion and switching, and sample analysis in zero-flow conditions.

You will find below a short description of each instrument features, as well as three examples of experimental setup. These simple examples can be used in a real experiment, but the applications of the MUX Switches extend far beyond them.

MUX Standard 2/2

The MUX Standard 2/2 consists of an array of solenoid valves (i.e. valves with one inlet and one outlet) and is designed to permit and shut off fluid flow. When actuated, these valves allow fluid to pass through, but at rest (default state) the flow is interrupted.

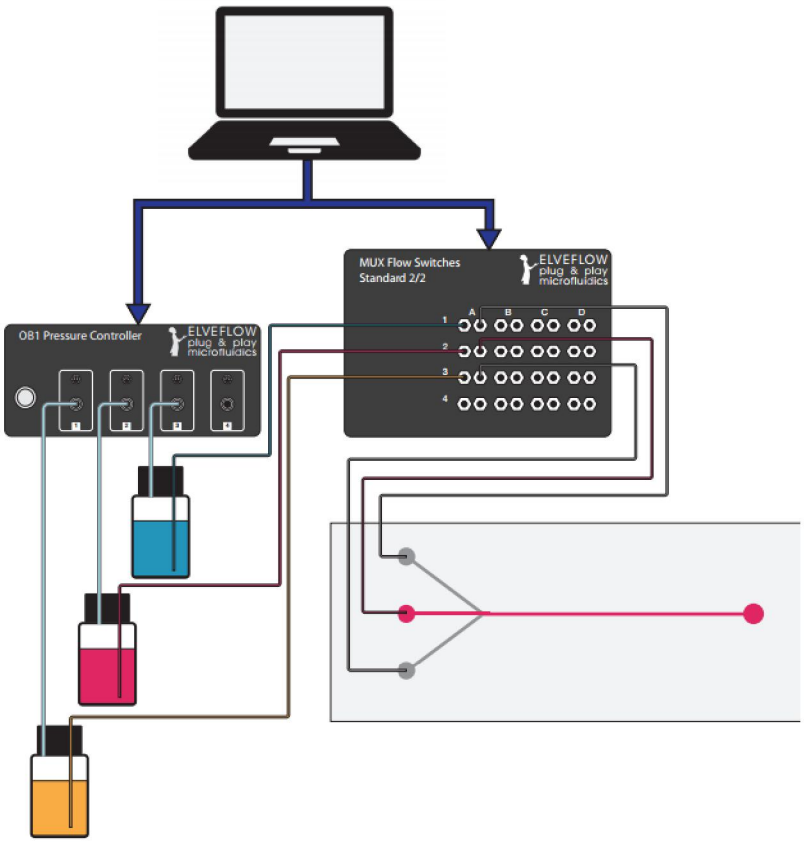
This instrument is typically used witha pressure controller (such as an AF1 or an OB1) that pressurizes samples inside reservoirs. These pressurized reservoirs are connected to the MUX Standard 2/2 to selectively inject the pressurized samples into a microfluidic chip in accordance with a valve pattern set via the Elveflow Smart Interface.



MUX 2/2 setup example

In this example, a MUX 2/2 is used with an OB1 pressure controller as the pressure source, but we could just as easily have used an AF1pressure generator per reservoir. Both MUX 2/2 and OB1 communicate with the computer via the Elveflow Smart Interface. The OB1 is used to apply a stable pressure to the liquids stored in the reservoirs. Each fluidic outlet of these reservoirs is connected to a valve of the MUX 2/2, which is then connected to the microfluidic chip. When actuated using the Elveflow Smart Interface, these valves allow fluid to pass through (see red liquid flowing into the chip), but at rest (default state) the flow is interrupted.

Remember to never use acetone with the MUX and keep the pressure at valve level below 2 bar (29 psi).



MUX Standard 3/2

The MUX Standard 3/2 uses 3-Way solenoid valves, i.e. valves with three ports (NC: Normally Closed, C: Common, and NO: Normally Open), and two positions:

1. Normally Closed port linked to Common port;
2. Normally Open port linked to Common port.

When NC port is open, the NO is closed and vice versa.

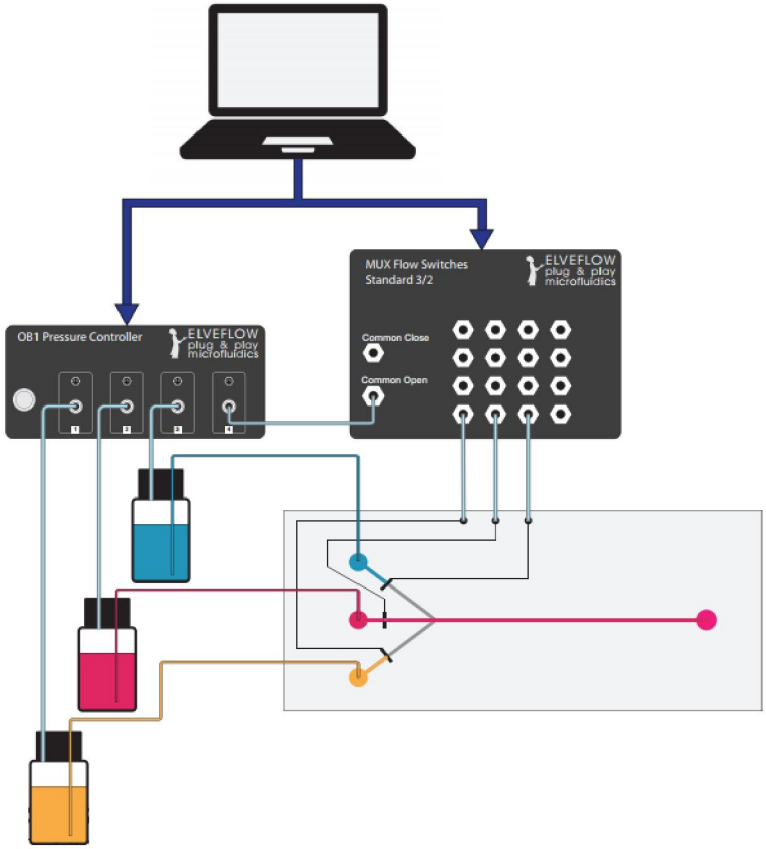
The MUX Standard 3/2 offers 16 of these 3-way valves of which Common port is accessible at the front side of the instrument, together with 2 additional connectors («Common Close» and «Common Open»). A specific manifold connects all NC ports to the Common Close connector, and all NO ports to the Common Open connector. The MUX Standard 3/2 is generally used to alternately apply the pressures set a the Common Close and Common Open inlets to microfluidic channels, in accordance with a valve pattern controlled with the Elveflow Smart Interface.

MUX 3/2 setup example

In this example, a MUX 3/2 is used with an OB1 pressure controller as the pressure source, but an AF1 pressure generator can also be used. Both MUX 3/2 and OB1 communicate with the computer via the Elveflow Smart Interface. The OB1 is used to apply a stable pressure to the liquids stored in the reservoirs, which are then connected to a multilayer microchip that uses pneumatic PDMS microvalves. The OB1 is also used to apply a specific pressure to a pressure inlet of the MUX 3/2. The second MUX 3/2 pressure inlet is at atmospheric pressure.

Microfluidic pneumatic microvalves use the deflection of a PDMS membrane to interrupt flow and can be actuated by alternately applying the OB1 set pressure and the atmospheric pressure. This principle is used to block (blue an yellow liquids) or let flow (red) the liquids connected to the chip, using the Elveflow Smart Interface to open or close the selected solenoid valves.

Remember to never use acetone with the MUX and keep the pressure at valve level below 2 bar (29 psi).



MUX Premium

The MUX Premium uses a 4 x 4 matrix of 2-Way solenoid valves (i.e. valves with one inlet and one outlet) and is designed to permit and shut off fluid flow. When actuated, these valves allow fluid to pass through, but in default state flow is interrupted.

The front side of this instrument shows 8 connectors: 4 inputs and 4 outputs.

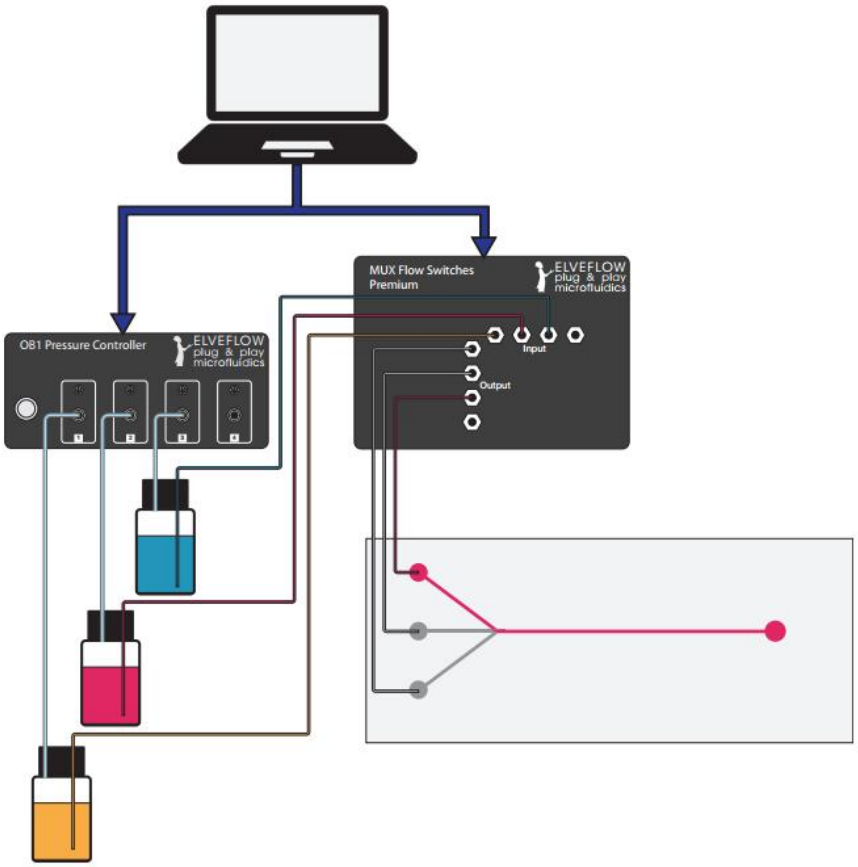
The major difference between the MUX Standard 2/2 and the MUX Premium is that the latter has a specific 4x4 matrix-shaped manifold that connects any inlet to any outlet. Therefore, the MUX Premium can be used to direct the flow coming from a pressurized reservoir connected to any of the four inlets towards any of the four outlets, according to a valve pattern set with the Elveflow Smart Interface.

MUX Premium setup example

In this example, a MUX Premium is used with an OB1 pressure controller as the pressure source, (an AF1 pressure generator can also be used). Both MUX Premium and OB1 communicate with the computer via the Elveflow Smart Interface. The OB1 is used to apply a stable pressure to the liquids stored in the reservoirs, which are then connected to the MUX Premium inlets.

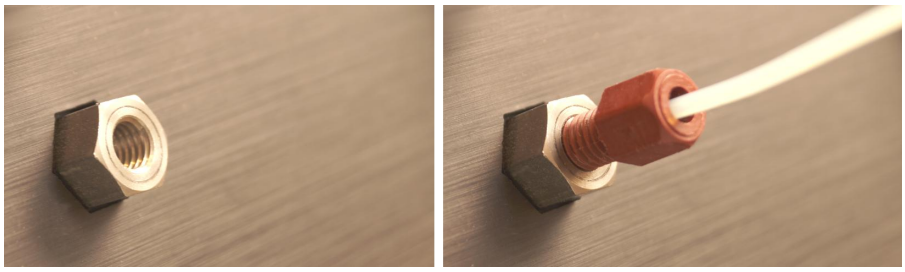
The MUX Premium has an internal 4 x 4 matrix-shaped manifold that connects any inlet to any outlet, thus it can be used to direct any fluid coming from one of the inlets to any outlet. In this example, the red fluid connected to the second inlet is injected into the microchip using outlet #3. Subsequently, another pressurized fluid (e.g. blue or yellow) can be injected into the same microchannel, using the same outlet #3, to perform sequential injections experiments.

Remember to never use acetone with the MUX and keep the pressure at valve level below 2 bar (29 psi).

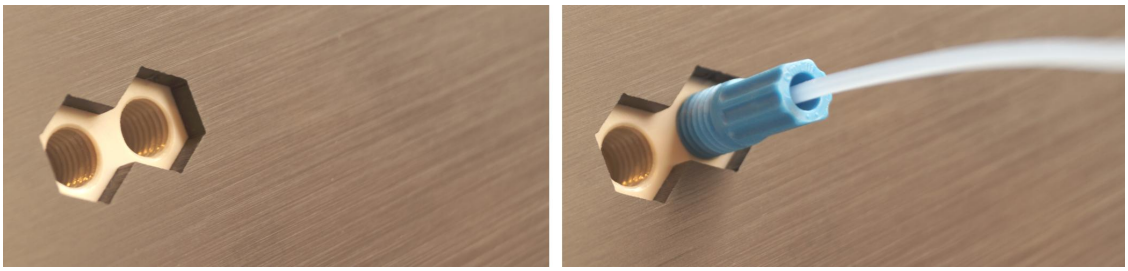


Connecting microfluidic tubing to the MUX

There are two different types of female connectors on the façade of the MUXs. Observe these connectors and use the corresponding flangeless nut and ferrule. Both models accept the standard tubing.



MUX Standard 3/2 and MUX Premium



MUX Standard 2/2

Software installation

Minimum system requirements

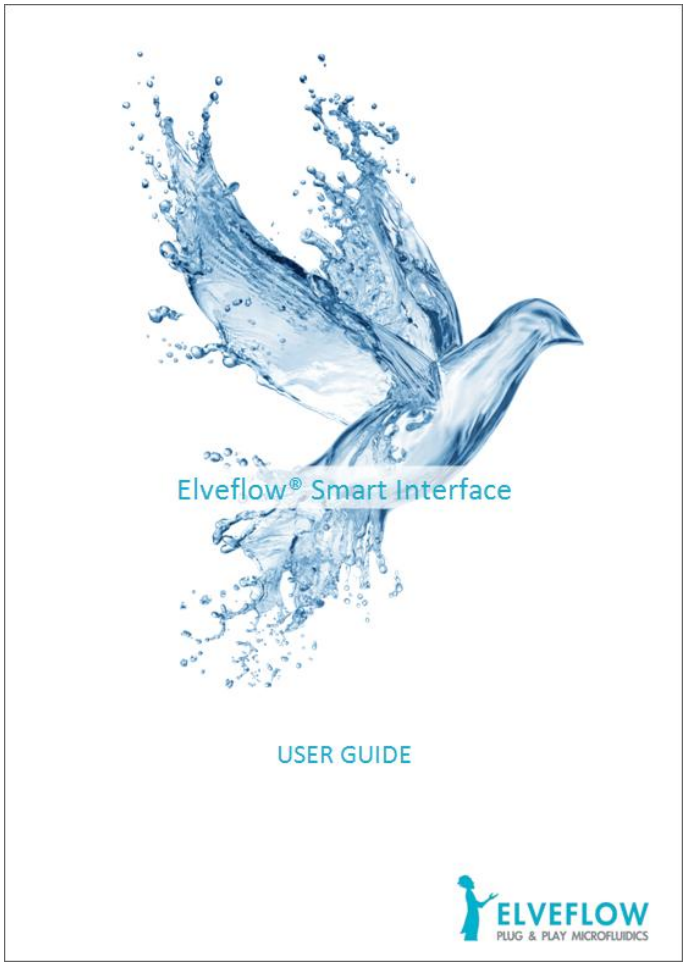
- Window XP SP3 or later - both 32 and 64-bit versions are supported;
- USB 2.0 port or faster;
- 1 GB RAM;
- 3.0 GHz Pentium 4;
- 1 GB of free hard disk space.

Elveflow Smart Interface: Installation steps

1. Plug the Elveflow® USB flash drive tothe computer.
2. Open the Elveflowfolder.
3. Run Install.exe.
4. Follow the instructions presented by the installation assistant.
5. **Restart your computer** when prompted to finish the installation process.

Using the Elveflow Smart Interface

The Elveflow® Smart Interface's main features and options are **covered by a specific guide**.Please refer to this guide for a detailed description.



You will also find dedicated user guides for:

- The other instruments of the Elveflow product line;
- Flow sensors;
- Accessories for microfluidics (reservoirs, flow restrictors, etc.).

Cleaning and storing

Cleaning the MUX after use is mandatory in order to prevent solid depositions in its valves. These depositions may cause leakages and eventually render the valves unusable.

The MUX is cleaned by simply pushing fluids through its valves.**Never insert any solids in the valves**, e.g. plastic or metallic sticks, in order to clean the MUX. You risk permanently damaging the instrument.

Cleaning protocols

The following protocols are general examples. Add washing steps according to the substances used during the experiment. Before washing the MUX with any substance, its **chemical compatibility** with the wetted materials must be checked. The wetted materials are PEEK, FKM (Viton) and POM (Delrin).

Do not flow acetone through the valves.

When cleaning the MUX after flowing substances with additives, such as salts or surfactants, start by flowing the substance without any additive.

Always finish by the standard protocol below. Isopropyl alcohol is a very volatile solvent and does not leave any residues, as opposed to water and acetone.

Standard cleaning protocol

- 1 mL of isopropyl alcohol;
- 30 s of air flushingto dry the valve.

Example of cleaning protocol for PBS-BSA

- 5 mL of deionized water;
- 5 mL of 1M acetic acid + 10% SDS;
- 1 mL of isopropyl alcohol;
- 30 s of air flushing to dry the valve.

Example of cleaning protocol for fluorinated oil with surfactant

- 5 mL of fluorinated oil;
- 1 mL of isopropyl alcohol;
- 30 s of air flushing to dry the valve.

Storing conditions

Always dry the MUX valves with clean, dry air before storing it.

Supplementary information

Conditions of use

Terms and conditions of use

We strongly believe in the intrinsic quality of our microfluidic instruments line and we hope that you will be pleased with your purchase. However, in the unlikely event that you should receive damaged or incorrect goods in your delivery, please notify us within 7 days of receipt.
You will be offered the option of a refund or an exchange (provided the goods are in stock).
You may be asked to return goods for inspection. In this case we will refund the shipping fees.
Should the damaged or incorrect item be no longer available, you will be given the option of a refund.
Please note that goods that become damaged or broken after 7 days of receipt cannot be returned.

Unwanted items

If for any reason you do not wish to keep your purchase and would like a store credit, then please notify us within 7 days of receipt.
We cannot accept unwanted returns that have been opened, used or damaged by the customer.
For unwanted goods, we allow up to 14 days for the return of goods. We will only issue a credit upon receipt of all returned goods.
Please note that we are unable to refund your costs in returning unwanted goods or the delivery costs of sending the goods to you in the first place.

Cancellations
If you wish to cancel your order please email us immediately: contact@elveflow.com.

Privacy Policy
Customer details remain private and confidential and will not be released to a third party unless required to do so by law.
We use the information we collect about you to process orders, to provide a more personalized shopping experience and, if you request it, to notify you about new products, special offers or other information that may be of interest to you. We do not sell or pass on any personal information to any other Companies or Organizations.

Payments & Procedures
Payment from private customers must be paid for in advance of shipment.Trade orders from registered companies or organizations can be invoiced. Payment is due strictly within 30 days of the invoice date.

Products & Prices
Please note that some goods may vary in style, color or detail from the image shown.We reserve the right to change prices at any time.

Transport and storage

Be careful not to harm or shake Elveflow products while moving Elveflow® products must not be transported when plugged. Store products in standard conditions in an adapted box (typically the one used to send you the product).
Humidity and temperature must not exceed those of the specifications.

Exclusive remedies

The remedies provided herein are the customer's sole and exclusive remedies. Elveflow® shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

Safety Information

THE FOLLOWING GENERAL SAFETY PRECAUTIONS MUST BE FOLLOWED DURING ALL PHASES OF OPERATION, SERVICE, AND REPAIR OF THIS INSTRUMENT. FAILURE TO COMPLY WITH THESE PRECAUTIONS OR WITH SPECIFIC WARNINGS ELSEWHERE IN THIS MANUAL VIOLATES SAFETY STANDARDS OF DESIGN, MANUFACTURE, AND INTENDED USE OF THE INSTRUMENT. ELVESYS ASSUMES NO LIABILITY FOR THE CUSTOMER'S FAILURE TO COMPLY WITH THESE REQUIREMENTS.

Important advices

Elveflow products are for research use only.
No liquid should enter into the OB1 otherwise this would void the warranty.
The pressure source connected to the OB1 must be dry, dust and oil free, and of maximum 10 bar.
Please take the required action to ensure that these conditions are met and maintained.

Conditions of use

This instrument is intended for indoor use. It is designed to operate at a maximum relative humidity of 60% and at altitudes of up to 2000 meters. Operating temperature range is +5°C to 50°C.

Do not operate in wet/damp conditions: to avoid electric shock, do not operate this product in wet or damp conditions.

Do not operate in an explosive environment: do not operate the equipment in the presence of explosive or flammable gases or fumes.

Warning: Do not use this product as safety or emergency stop devices or in any other application where failure of the product could result in personal injury. The protective features of this product may be impaired if it is used in a manner not specified in the operating instructions. Before installing, handling, using or servicing this product, please consult the data sheet and user manual.

Failure to comply with these instructions could result in death or serious injury. If the buyer shall purchase or use Elveflow® products for any unintended or unauthorized application, the buyer shall defend, indemnify and hold harmless Elveflow® and its officers, employees, subsidiaries, affiliates and distributors against all claims, costs, damages and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if Elveflow® is allegedly negligent with respect to the design or the manufacture of the product.

Pressurized Equipment

Care must be taken when the Elveflow pump is pressurised to ensure that the instrument is not damaged in any way.

Protection

Safety glasses and labcoat should be worn at all times when using an elveflow pressure pump due to the use of pressurised equipment. This is particularly important when hazardous liquids are used.

Electrictity advices

Use Elveflow® instruments with the provided power unit only. Maintenance should only be attempted by qualified Elveflow® personnel. Removal of the back panel may invalidate any warranty.

Before applying power: verify that the line voltage matches the product's input voltage requirements and the correct fuse is installed. Use only the specified line cord for this product and make sure the line cord is certified for the country of use.

Fuses: only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short circuited fuse holders. To do so could cause a shock or fire hazard.

Keep away from live circuits: operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed.

To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

ESD precautions: the inherent design of this component causes it to be sensitive to electrostatic discharge (ESD). To prevent ESD-induced damage and/or degradation, take customary and statutory ESD precautions when handling this product.

Maintenance advices

Maintenance should only be attempted by qualified Elveflow® personnel.

Removal of the back panel may invalidate any warranty.

Do not service or adjust alone:do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

Do not substitute parts or modify instrument: because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument.

Return the instrument to an Elveflow® Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

Instruments which appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified Elveflow® personnel.

CE compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Electromagnetic Compatibility

COUNCIL DIRECTIVE 89/336/EEC of 3 May 1989

This directive has been amended by the following Council Directives:

1. 92/59/eec of 29 June 1992 (General Product Safety)

2. 93/68/eec of 22 July 1993 (CE Marking directive)

3. 99/5/ec: Directive of Radio Equipment & Telecommunications Terminal Equipment (R&TTE).

Warranty

ELVEFLOW is a brand of ELVESYS Innovation Center.

The ELVESYS hardware products are warranted against defects in material and workmanship for a period of one year from date of delivery. ELVESYS software and firmware products, that are designated by ELVESYS for use with a hardware product and when properly installed on that product, are warranted not to fail to execute their programming instructions due to defects in material and workmanship for a period of 60 days from date of delivery. During the warranty period ELVESYS will, either repair or replace products that prove to be defective. ELVESYS does not warrant that the operation for the software, firmware or hardware shall be uninterrupted or error free. For warranty service, this product must be returned to a service facility designated by ELVESYS. Customer shall prepay shipping charges (and shall pay all duty and taxes) for products returned to ELVESYS for warranty service. Except for products returned to a Customer from another country, ELVESYS shall pay for return of products to the Customer.

ELVESYS does not assume any liability arising out of any application or use of any product or circuit and specifically disclaims any and all liability, including without limitation consequential or incidental damages. All operating parameters, including without limitation recommended parameters, must be validated for each customer's applications by customer's technical experts. Recommended parameters can and do vary in different applications. ELVESYS reserves the right, without further notice, (i) to change the product specifications and/or the information in this document and (ii) to improve reliability, functions and design of this product.

Limitation of warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Customer, Customer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation and maintenance.